Rye Cover Crops in a Corn Silage-Soybean Rotation

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Introduction

Corn harvested for silage leaves the soil surface bare and unprotected from early fall until planting the following spring. As a result, dairy farmers and NRCS personnel in Iowa have been interested in using a rye winter cover following corn silage to protect the soil from erosion and to provide grazing or additional silage in the spring. Winter cover crops, however, have rarely been grown in Iowa. There is little information on the expected biomass production of a rye cover crop in this cropping system or its effect on the following corn silage or soybean crop. Additionally, if corn stover is harvested for biofuel production, then a similar need for soil protection would exist.

Objectives

- To determine the biomass production of a rye cover crop in a corn silage-soybean rotation in Iowa.
- To determine the effect of a rye cover crop on corn silage and soybean yields.

Materials and Methods

A field site was established in 2002 on Iowa State University's Boyd Farm (Lat. 42° 00' 26"; Long. -93° 47' 31") 14.3 km west of Ames, IA. The site had a 2% slope and the predominant soils at the site were a Nicollet clay loam and a Clarion loam. The site was divided into 10 blocks with 5 blocks planted to corn silage and 5 blocks planted to soybean each year. The blocks to which corn and soybean were planted were rotated from year-to-year. Four treatments were imposed and randomly assigned to plots within blocks. Individual plots were 54.9 m long and 3.8 m wide and consisted of 5 rows 0.76 m apart. The four cropping system treatments were: (1) soybean followed by a rye cover crop – corn silage followed by a rye cover crop; (2) soybean followed by a rye cover crop – corn silage with no cover crop; (3) soybean with no cover crop – corn silage followed by a rye cover crop; (4) soybean with no cover crop – corn silage with no cover crop. The experimental design was a randomized complete block design with 5 reps or blocks within a crop. To simplify this presentation, similar treatments (e.g. rye following soybean) were averaged within blocks and differences between treatments within blocks were calculated. The data were analyzed using an ANOVA, Tukey's Studentized Range Test at the 0.10 probability level, and 90% Confidence Intervals. Data from 2003 to 2007 are presented.

Corn and soybean were planted in late April and early May with a no-till planter using typical fertilizer and herbicide management. All plots were managed without tillage. Nitrogen fertilizer was a applied with a point injector and P and K was applied with a coulter applicator. Corn silage was

Materials and Methods (cont.)

harvested in early to mid September with a silage chopper and yield determined using a weigh wagon with a load cell. Subsamples were taken to determine silage water content at harvest and dry weight yield of silage was calculated. Soybean was harvested in mid to late September with an instrumented combine with an onboard weigh tank and moisture meter. Soybean grain yield was corrected to a water content of 0.13 g g^{-1}.

A rye cover crop (cv. "Rymin") was planted with a no-till grain drill as soon as possible after corn silage and soybean harvest. On average, rye was planted 19 days earlier after corn silage than after soybean. Two rye cover crop shoot samples were taken from each plot in the spring. Each sample was taken from an area 0.50 x 0.76 m. Samples were dried at 60° C and weighed. Immediately after sampling the cover crop was killed by spraying with glyphosate. This usually occurred 10-14 days before planting corn or soybean.

Results and Discussion

Our previous research has indicated that corn grain yields are sometimes reduced following a rye cover crop. In this experiment we wanted to determine whether corn silage yields were reduced following a rye cover crop. Table 1 shows that silage yields following a rye cover crop were significantly reduced only in 2006. Lack of significant differences, however, do not prove that the silage yields were equivalent. Examining the 90% confidence interval for the difference of the means we see that there is a 90% probability that the reduction in silage yield was less than 2.38 Mg ha^{-1}

Table 1 Corn Silage Dry Weight

Year	Following Soybean wo Rye (Trts 3 & 4)	Following Soybean w Rye (Trts 1 & 2)	Difference	90% Confidence Interval of Difference
	Mg ha^{-1}			
2003	18.98	18.62	0.36 ns	-1.65 --- 2.38
2004	21.82	21.72	0.10 ns	-1.44 --- 1.64
2005	19.08	18.53	0.55 ns	-0.61 --- 1.72
2006	18.56	17.62	0.93 *	0.24 --- 1.63
Avg.	19.61	19.12	0.49 ns	-0.06 --- 1.04

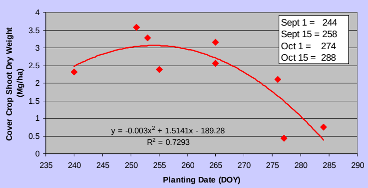
Table 2 Soybean Grain Yield

Year	Following Silage wo Rye (Trts 2 & 4)	Following Silage w Rye (Trts 1 & 3)	Difference	90% Confidence Interval of Difference
	Mg ha^{-1}			
2003	2.60	2.59	0.01 ns	-0.12 --- 0.15
2004	3.63	3.65	-0.02 ns	-0.29 --- 0.25
2005	4.85	4.77	0.08 ns	-0.08 --- 0.25
2006	3.40	3.52	-0.12 ns	-0.31 --- 0.07
Avg.	3.62	3.63	-0.01 ns	-0.09 --- 0.07

Table 3 Rye Cover Crop Shoot Dry Weight

Year	Rye Cover Crop Following Silage (Trts 1 & 3)	90% Confidence Interval	Rye Cover Crop Following Soybean (Trts 1 & 2)	90% Confidence Interval
	Mg ha^{-1}			
2003	2.31 **	1.99 --- 2.62	0.81	0.77 --- 0.86
2004	3.28 **	3.01 --- 3.56	2.10	1.70 ---2.50
2005	3.16 **	2.90 --- 3.43	2.57	2.24 --- 2.89
2006	2.38 **	2.10 --- 2.65	0.75	0.65 --- 0.86
2007	3.58 **	3.06 --- 4.09	0.44	0.34 --- 0.55
Avg.	2.94 **	2.73 --- 3.15	1.33	1.03 --- 1.64

Fig 1 Rye Cover Crop Shoot Dry Weight Vs. Planting Dates over the Five Years



Results and Discussion (cont.)

in each of the four years. For the four year average the upper bound of the 90% confidence interval was 1.04 Mg ha^{-1}. Because the lower bound of the 90% confidence interval is close to 0, it is probable that there is some yield reduction averaged over time.

Soybean grain yield was not significantly decreased following a rye cover crop in any year (Table 2). Additionally, the 90% confidence interval for the difference was less than 0.25 Mg ha^{-1} in all four years. If managed properly, we do not think that soybean yield will be reduced by a rye cover crop.

Rye cover crop shoot dry weight in the spring was greater following corn silage than following soybean in all 5 years (Table 3). We believe that this is primarily because of the earlier planting date following corn silage, which on average was 19 days earlier than that following soybean. Fig 1 shows shoot dry matter versus planting date for the 5 years. Although, combining the data across years in this way is not really valid because there were substantial differences between years in rye growth, the figure demonstrates that rye growth is reduced because of the later planting dates. Averaged over the 5 years a rye cover crop following corn silage produced an average of 2.94 Mg ha^{-1} of biomass with a lower limit of 2.73 Mg ha^{-1} for the 90% confidence interval. Thus, the rye biomass production makes up for even the largest probable silage yield reduction in any of the four years.

Conclusions

- Silage yields may be reduced following a rye cover crop but averaged over years the reduction is likely to be less than 1.04 Mg ha^{-1}.
- Soybean yields were not reduced following a rye cover .
- Rye cover crop biomass was greater following corn silage than following soybean because of the earlier planting date.
- Averaged over four years a rye cover crop after corn silage produced at least 2.73 Mg ha^{-1} of biomass, which is considerably greater than the maximum probable decrease in corn silage biomass.

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Fig 2 Rye cover crop provides ground cover following corn silage.

Fig 3 Rye cover crop following corn silage in the spring with greater than 3.0 Mg ha^{-1} of shoot growth.C

Fig 4 Soybean growing up through a rye cover crop following corn silage that was killed with glyphosate.